

**RANCHO LOS AMIGOS**  
NATIONAL REHABILITATION CENTER



# Contracture Management Overview and Treatment Options

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# Objectives

- Define contractures
- Discuss incidence of contractures following spinal cord injury
- Identify the various causes of contractures
- Discuss the secondary effects of contractures
- Describe the synergistic approach to contracture management





# What is a contracture?

Adaptive shortening of soft tissue that prevents normal mobility or flexibility of a joint

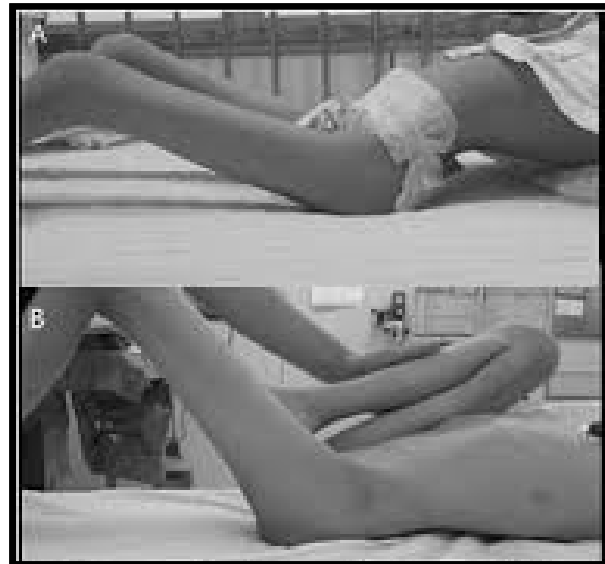
- ROM limitation – unable to achieve normative values
- Soft tissue or bony restrictions
- All planes of motion are susceptible
- Potential for additional sequelae, complications, and co-morbidities
- Source of deformities and postural misalignment





## Contractures - Severity

- Slight restriction to total arthrodesis (fusion)
- Amount of ROM restriction, age of contracture, joint end feel
- Progressive, worsening over time





# Contractures – Incidence in SCI

## Diong et al. findings

- At one year, 60-66% of participants had at least one contracture
- Paraplegia – 47% of participants
- Tetraplegia – 83% of participants
- Joints most affected were: ankles, wrists, and shoulders
- Unable to discriminate between contributing factors causing contractures



# Factors contributing to contractures

- Muscle imbalance at a joint due to habitual activation of agonist muscle (spastic and voluntary) and impaired antagonist motor control (weakness or paralysis)
- Loss of muscle elasticity due to prolonged positioning and immobilization
- Heterotopic ossification
- Pain
- Trauma (Fx and soft tissue restriction)



## Consequences of Contractures

- Interferes with mobility, gait, and transfers
- Interferes with self-care
- Increased risk of falls
- Pain
- Sleep disturbance
- Increased risk of skin breakdown
- Inability to tolerate splints
- Increased burden of care
- Deformities
- Decrease quality of life
- Poor postural alignment – sitting and standing







# Goals of Contracture Management

Slow, stop, or reverse muscle contractures for:

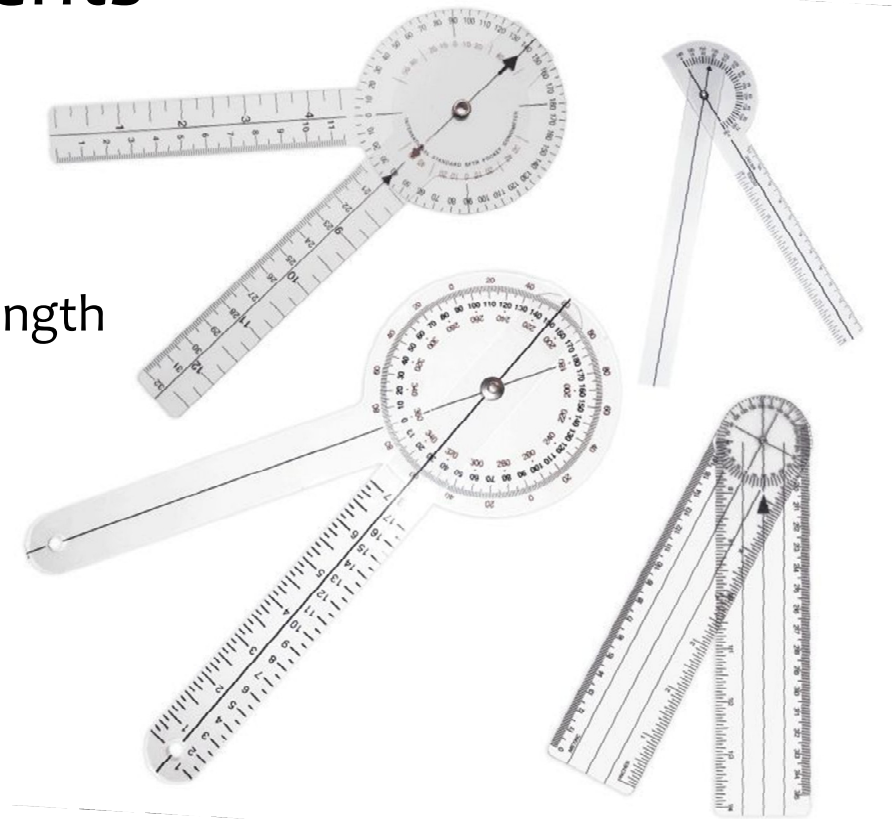
- Improved posture/positioning
- Improved mobility and/or ambulation
- Increase independence or ease of assistance with self-care
- Improve functional ability and increase independence
- Decrease risk of falls
- Decrease pain
- Improve sleep
- Improve therapy outcomes
- Decrease burden of care
- Improved cosmesis
- Improve quality of life





# Assessments

- Patient's history
- Functional assessment
- ASIA Impairment Scale – motor strength
- Goniometry – AROM/PROM
- Tone – Modified Ashworth Scale
- Spasticity – Modified Tardieu Scale
- Pain Scale
- Radiologic studies if necessary





<b>INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)</b>		Patient Name _____ Date/Time of Exam _____			
		Examiner Name _____ Signature _____			
<b>RIGHT</b>	<b>MOTOR KEY MUSCLES</b>	<b>SENSORY KEY SENSORY POINTS</b> Light Touch (LTR)   Pin Prick (PPR)	<b>SENSORY KEY SENSORY POINTS</b> Light Touch (LTL)   Pin Prick (PPL)	<b>MOTOR KEY MUSCLES</b>	<b>LEFT</b>
<b>UER</b> (Upper Extremity Right)	Elbow flexors C5 Wrist extensors C6 Elbow extensors C7 Finger flexors C8 Finger abductors (5th finger) T1	C2 C3 C4 C5 C6 C7 C8 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1	C2 C3 C4 C5 C6 C7 C8 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1	C5 Elbow flexors C6 Wrist extensors C7 Elbow extensors C8 Finger flexors T1 Finger abductors (5th finger)	<b>UEL</b> (Upper Extremity Left)
<b>LER</b> (Lower Extremity Right)		Hip flexors L2 Knee extensors L3 Ankle dorsiflexors L4 Long toe extensors L5 Ankle plantar flexors S1	S2 S3 S4-5	L2 Hip flexors L3 Knee extensors L4 Ankle dorsiflexors L5 Long toe extensors S1 Ankle plantar flexors	<b>LEL</b> (Lower Extremity Left)
(VAC) Voluntary Anal Contraction (Yes/No) <input type="checkbox"/>		S2 S3 S4-5	S2 S3 S4-5	(DAP) Deep Anal Pressure (Yes/No) <input type="checkbox"/>	
<b>RIGHT TOTALS</b> (MAXIMUM)		<input type="text"/> (50)	<input type="text"/> (56)	<input type="text"/> (56)	<b>LEFT TOTALS</b> (MAXIMUM)
<b>MOTOR SUBSCORES</b>		<b>SENSORY SUBSCORES</b>			
UER <input type="text"/> + UEL <input type="text"/> = <b>UEMS TOTAL</b> <input type="text"/>		LTR <input type="text"/> + LTL <input type="text"/> = <b>LT TOTAL</b> <input type="text"/>		PPR <input type="text"/> + PPL <input type="text"/> = <b>PP TOTAL</b> <input type="text"/>	
MAX (25) (25) (50)		MAX (56) (56) (112)		MAX (56) (56) (112)	
<b>NEUROLOGICAL LEVELS</b> <small>Steps 1-5 for classification as on reverse</small>		<b>3. NEUROLOGICAL LEVEL OF INJURY (NLI)</b> <input type="text"/>		<b>4. COMPLETE OR INCOMPLETE?</b> <input type="checkbox"/> <small>Incomplete = Any sensory or motor function in S4-5</small>	
1. SENSORY <input type="text"/> R <input type="text"/> L 2. MOTOR <input type="text"/> R <input type="text"/> L		<b>5. ASIA IMPAIRMENT SCALE (AIS)</b> <input type="text"/>		<small>(No complete injuries only)</small> <b>ZONE OF PARTIAL PRESERVATION</b> <small>Must contain level with any innervation</small>	
SENSORY <input type="text"/> R <input type="text"/> L MOTOR <input type="text"/> R <input type="text"/> L					

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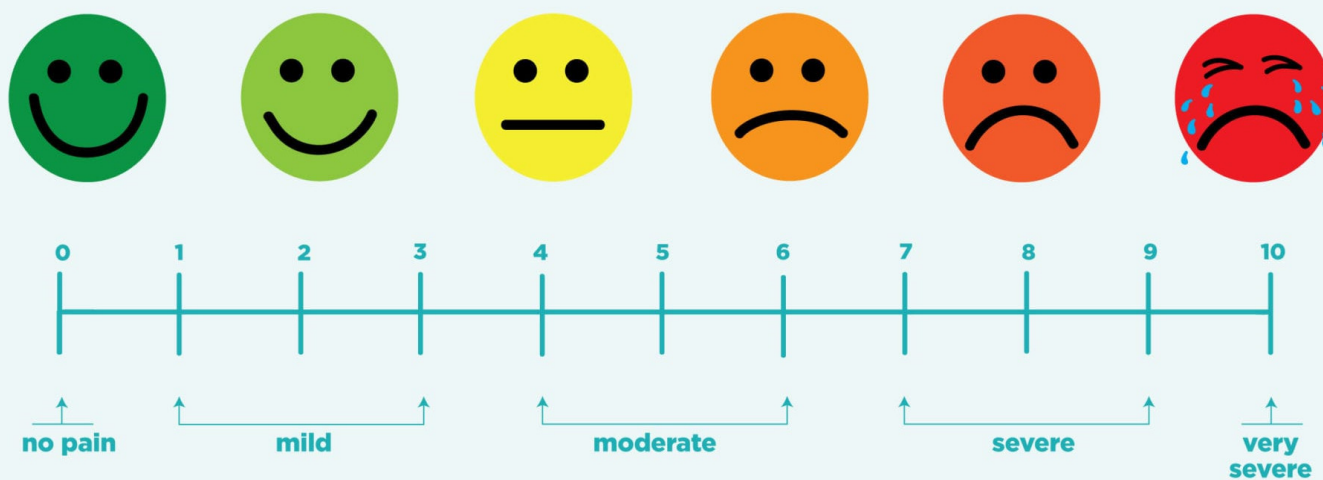


# Modified Ashworth Scale

0	No Increase in tone
1	Slight increase in tone. Catch/Release at end ROM
1+	Slight increase in tone. Catch/Release and resistance throughout the remainder (less than half) of the ROM
2	More marked increase in tone throughout ROM, but affected part moved easily
3	Considerable increase in tone, passive movements difficult
4	Affected part rigid in flexion or extension



# Pain Scale





# Therapy Interventions

- PREVENTION! PREVENTION! PREVENTION!
- Positioning to prevent or correct deformities
- AROM/PROM to regain and maintain joint mobility
- Exercise for muscle activation and strengthening
- Neuromuscular reeducation to restore normal movement patterns
- NMES as an adjunct for promoting increased ROM and strength
- Modalities to assist with tissue extensibility or pain management
- Educating and training the patient and caregivers





# Managing Immobility

- Stretch
  - Daily stretching routine should be initiated as early as possible to prevent further joint immobility/tissue shortening.
  - Stretches should be performed slowly and gently, and held for a prolonged time
- Positioning
  - Resting position of the joint is typically in a position that opposes or minimizes flexion
  - Supine vs. Prone
- Splinting/Casting
  - Prevention of joint deformity
  - Provide prolonged stretch to the muscle/joint
- Education
  - Teach pt and caregiver how to perform stretches and positioning



**Table 1** A guide to the types and causes of contractures that tetraplegics and paraplegics are susceptible to developing.

<i>Type of contracture</i>	<i>Levels of lesions susceptible</i>	<i>Voluntary control of agonist and antagonist muscles</i>	<i>Postures that increase susceptibility to contractures</i>	<i>Postures that help prevent contractures</i>	<i>Activities limited by contractures and activities that help prevent contractures</i>
Loss of shoulder flexion	C5 and above	<ul style="list-style-type: none"> <li>● flexors – weak (C5) or absent (C4 and above)</li> <li>● extensors – weak (C5) or absent (C4 and above)</li> </ul>	<ul style="list-style-type: none"> <li>● sitting or lying with arms beside body</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with shoulders flexed and supported on high table</li> <li>● sidelying with shoulders in flexion</li> </ul>	<ul style="list-style-type: none"> <li>● lifting hand to mouth/face (C5)</li> <li>● dressing upper limbs (independent or dependent)</li> </ul>
Loss of shoulder abduction	C5 and above	<ul style="list-style-type: none"> <li>● abductors – present (C5) or absent (C4 and above)</li> <li>● adductors – weak (C5) or absent (C4 and above)</li> </ul>	<ul style="list-style-type: none"> <li>● sitting or lying with arms beside body</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with shoulders abducted and supported on high table</li> <li>● lying in supine position with arms supported on abduction boards</li> </ul>	<ul style="list-style-type: none"> <li>● lifting hand to mouth/face (C5)</li> <li>● dressing upper limbs (independent or dependent)</li> </ul>
Loss of shoulder external rotation	C5 and above	<ul style="list-style-type: none"> <li>● external rotators – weak (C5) or absent (C4 and above)</li> <li>● internal rotators – weak (C5) or absent (C4 and above)</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with hands against chest on lapboard</li> <li>● lying in supine position or sidelying with hands across or on chest</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with hands away from chest</li> <li>● lying in supine position with hands off chest and shoulders externally rotated</li> </ul>	<ul style="list-style-type: none"> <li>● dressing upper limbs (independent or dependent)</li> </ul>
Loss of elbow extension	C5 and C6	<ul style="list-style-type: none"> <li>● extensors – absent*</li> <li>● flexors – present*</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with arms supported on lapboard</li> <li>● sitting with elbows actively flexed</li> <li>● lying in supine position with hands on chest</li> </ul>	<ul style="list-style-type: none"> <li>● using upper limbs to push manual wheelchair</li> <li>● sidelying or lying in supine position with elbows extended</li> </ul>	<ul style="list-style-type: none"> <li>● reaching</li> <li>● pushing manual wheelchair</li> <li>● transferring by bearing weight through upper limbs (C6)</li> </ul>
Loss of forearm supination	C4 and above	<ul style="list-style-type: none"> <li>● supinators – absent</li> <li>● pronators – absent</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with forearms pronated on lapboard</li> <li>● lying in supine position with hands on chest or with arms beside body and forearms pronated</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with forearms supinated</li> <li>● lying in supine position with arms beside body and forearms supinated</li> </ul>	<ul style="list-style-type: none"> <li>● dressing upper limbs (dependent)</li> </ul>
Loss of forearm pronation	C5	<ul style="list-style-type: none"> <li>● pronators – absent*</li> <li>● supinators – present*</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with elbows actively flexed and forearms actively supinated – due to contraction of biceps</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with forearms pronated</li> </ul>	<ul style="list-style-type: none"> <li>● controlling joystick on electric wheelchair</li> <li>● feeding</li> <li>● using hands to passively hold and manipulate objects</li> </ul>
Loss of wrist flexion	C5	<ul style="list-style-type: none"> <li>● flexors – absent</li> <li>● extensors – absent</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with elbows actively flexed and supinated and hence wrist passively extended – due to contraction of biceps</li> </ul>	<ul style="list-style-type: none"> <li>● sitting with forearms pronated and hands hanging over edge of lapboard (ie, with wrist in flexion)</li> </ul>	<ul style="list-style-type: none"> <li>● using hands to passively hold and manipulate objects</li> </ul>





Loss of MCP joint flexion	C8 and above	<ul style="list-style-type: none"> <li>flexors – weak (C8) or absent (C7 and above)</li> <li>extensors – weak (C7 and C8) or absent (C6 and above)</li> </ul>	<ul style="list-style-type: none"> <li>sitting with elbows actively flexed and supinated (C5) and hence MCP joints passively extended</li> <li>wearing hand splints that position MCP joints in extension</li> </ul>	<ul style="list-style-type: none"> <li>wearing hand splints that position MCP joints in flexion</li> </ul>	<ul style="list-style-type: none"> <li>using hands to passively hold and manipulate objects (C5)</li> <li>using passive tenodesis grip (C6 and C7) and using hands to actively hold and manipulate objects (C8)</li> </ul>
Loss of IP joint extension	C8 and above	<ul style="list-style-type: none"> <li>extensors – weak (C7 and C8) or absent (C6 and above)</li> <li>flexors – weak (C8) or absent (C7 and above)</li> </ul>	<ul style="list-style-type: none"> <li>wearing hand splints that position IP joints in flexion</li> <li>sitting with hand flexed around object</li> </ul>	<ul style="list-style-type: none"> <li>wearing hand splints that position IP joints in extension</li> </ul>	<ul style="list-style-type: none"> <li>using hands to passively hold and manipulate objects (C5)</li> <li>using passive tenodesis grip (C6 and C7) and using hands to actively hold and manipulate objects (C8)</li> </ul>
Loss of thumb abduction	C5 and above	<ul style="list-style-type: none"> <li>abductors – absent</li> <li>adductors – absent</li> </ul>	<ul style="list-style-type: none"> <li>sitting or lying with hands flat on a surface</li> </ul>	<ul style="list-style-type: none"> <li>wearing hand splints that position thumb in abduction</li> </ul>	<ul style="list-style-type: none"> <li>using thumb to passively hold and manipulate objects (C5)</li> </ul>
Loss of hip extension	L4 and above	<ul style="list-style-type: none"> <li>extensors – absent*</li> <li>flexors – present* (L2 and below) or absent (L1 and above)</li> </ul>	<ul style="list-style-type: none"> <li>sitting</li> <li>sidelying with hips and knees flexed</li> </ul>	<ul style="list-style-type: none"> <li>lying in prone position</li> <li>lying in supine position with hips extended</li> <li>standing and/or walking</li> <li>lying in supine position with abduction pillow between legs</li> </ul>	<ul style="list-style-type: none"> <li>standing and/or walking (T10 – L4) with or without orthoses</li> </ul>
Loss of hip abduction	L4 and above	<ul style="list-style-type: none"> <li>abductors – absent*</li> <li>adductors – present* (L2 and below) or absent (L1 and above)</li> </ul>	<ul style="list-style-type: none"> <li>sitting or lying with legs adducted</li> </ul>		<ul style="list-style-type: none"> <li>attending to personal hygiene (independent or dependent)</li> <li>transferring independently (C6 – L4)</li> </ul>
Loss of hip flexion and knee extension (hamstring contracture)	L3 and above	<ul style="list-style-type: none"> <li>hip flexors and knee extensors – absent</li> <li>hip extensors and knee flexors – absent</li> </ul>	<ul style="list-style-type: none"> <li>sitting</li> <li>sidelying with hips and knees flexed</li> </ul>	<ul style="list-style-type: none"> <li>sitting with hips flexed and knees extended (ankles supported on high stool)</li> <li>lying in supine position with hips flexed and knees extended (see Figure 1)</li> </ul>	<ul style="list-style-type: none"> <li>dressing and/or transferring from a long sitting position (C6 – L3)</li> <li>getting from floor to standing, or chair to standing, with knee extension orthoses (T10 – L3)</li> </ul>
Loss of knee extension	L3 and above	<ul style="list-style-type: none"> <li>knee extensors – absent</li> <li>knee flexors – absent</li> </ul>	<ul style="list-style-type: none"> <li>sitting</li> <li>sidelying with knees flexed</li> </ul>	<ul style="list-style-type: none"> <li>sitting with knees extended (ankles supported on stool)</li> <li>lying in supine position with knees extended</li> </ul>	<ul style="list-style-type: none"> <li>dressing and/or transferring from a long sitting position (C6 – L3)</li> <li>standing and/or walking with or without knee extension orthoses (T10 – L3)</li> </ul>
Loss of ankle dorsiflexion	L5 and above	<ul style="list-style-type: none"> <li>dorsiflexors – absent</li> <li>plantarflexors – absent</li> </ul>	<ul style="list-style-type: none"> <li>sitting in wheelchair with footplates too low</li> <li>lying in supine position or sidelying without footboards or foot splints</li> </ul>	<ul style="list-style-type: none"> <li>sitting or lying with feet supported at 90 degrees</li> <li>standing with wedge or sandbag under heads of metatarsals</li> </ul>	<ul style="list-style-type: none"> <li>standing and/or walking with or without ankle orthoses (T10 – L5)</li> </ul>
Loss of toe extension	L5 and above	<ul style="list-style-type: none"> <li>extensors – absent</li> <li>flexors – absent</li> </ul>	<ul style="list-style-type: none"> <li>sitting in wheelchair with forefoot over front edge of footplates</li> <li>not wearing shoes</li> <li>lying in supine position or sidelying without footboards or foot splints</li> </ul>	<ul style="list-style-type: none"> <li>wearing shoes</li> <li>sitting or lying with feet and toes supported standing</li> </ul>	<ul style="list-style-type: none"> <li>wearing ankle orthoses (T10 – L5) and/or shoes (L5 and above)</li> <li>standing (T10 – L5)</li> </ul>

The table indicates the level of lesion that is associated with the greatest susceptibility to each major function-limiting type of contracture. The effect of each level of lesion on strength of agonist and antagonist muscles is indicated. Asterisks identify situations in which contractures are commonly due to imbalance of strength between agonist and antagonist muscles (ie, good strength in agonist and poor or no strength in antagonist muscles). Also included are postures and activities of daily living that increase susceptibility to contractures and that help prevent contractures. For the sake of brevity the table is not comprehensive, only complete lesions have been considered and the description of patterns of weaknesses has been simplified. (MCP: metacarpophalangeal. IP: interphalangeal)

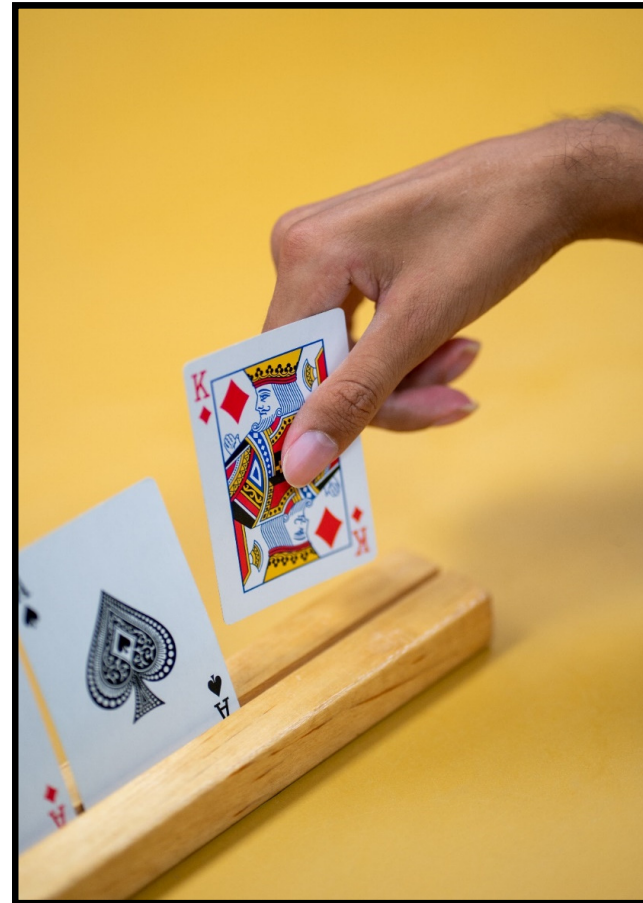
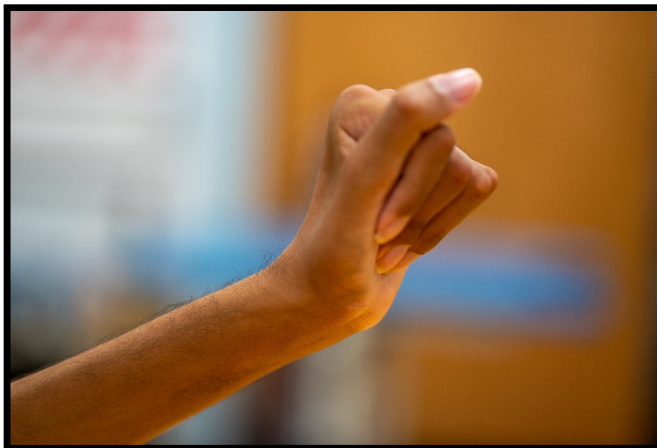


# Upper Extremity Orthoses





# Helpful Contractures





# Upper Extremity Orthoses





# Lower Extremity Orthoses





# Lower Extremity Orthoses





# Serial Casting





# Maintaining ROM

- Passive, active-assisted, or active ROM
- Daily stretching routine
- May incorporate heat for added benefit during stretching
- Teach patient how to effectively use gravity to assist with achieving full ROM
- Educating pt and caregivers
- Schedule time outside of therapy for stretching with patient care technicians







# Managing Muscle Imbalances

- AROM exercises to promote increased strength for weak innervated muscles
- AAROM with use of MAS, arm skates, leg skates, UE and LE ergometers
- NMES as an adjunct to exercise to evoke muscle activation





*“Increased muscle tone as a result of spasticity may result in loss of joint motion, leading to contractures. Prevention of contractures by joint mobilization is emphasized as a goal in the management of patients with spasticity.”*

*~MJ Botte et al.*



# Spasticity

- Abnormal involuntary muscle activation that is sustained or intermittent and associated with a CNS pathology (SCI)
- Other characteristics: increased tone, clonus, spasms, spastic co-contractions
- Can be categorized as:

“Good”	“Bad”
Postural control	Postural malalignment
Stance stability	Interferes with hygiene
Venous return	Pain



# Spasticity

Interferes with:

- QOL
- Interferes with functional ability
- Comfort (pain)

Factors that can aggravate spasticity

- Constipation, Bladder retention - Visceral
- UTI - Infection
- Pressure injuries - Noxious stimuli
- Triggers

Treatment focus

- Targeting spastic muscles that impede function, QOL, or comfort



# How do we manage spasticity for prevention of contractures?

A synergistic approach:

- Therapy
  - ROM, PROM/AROM/CPM
  - NMES
  - Splinting/Casting
- Medical Management
  - Oral Medication
  - Chemodenerivation
  - Motor Point Blocks
  - ITB pump
  - Surgery



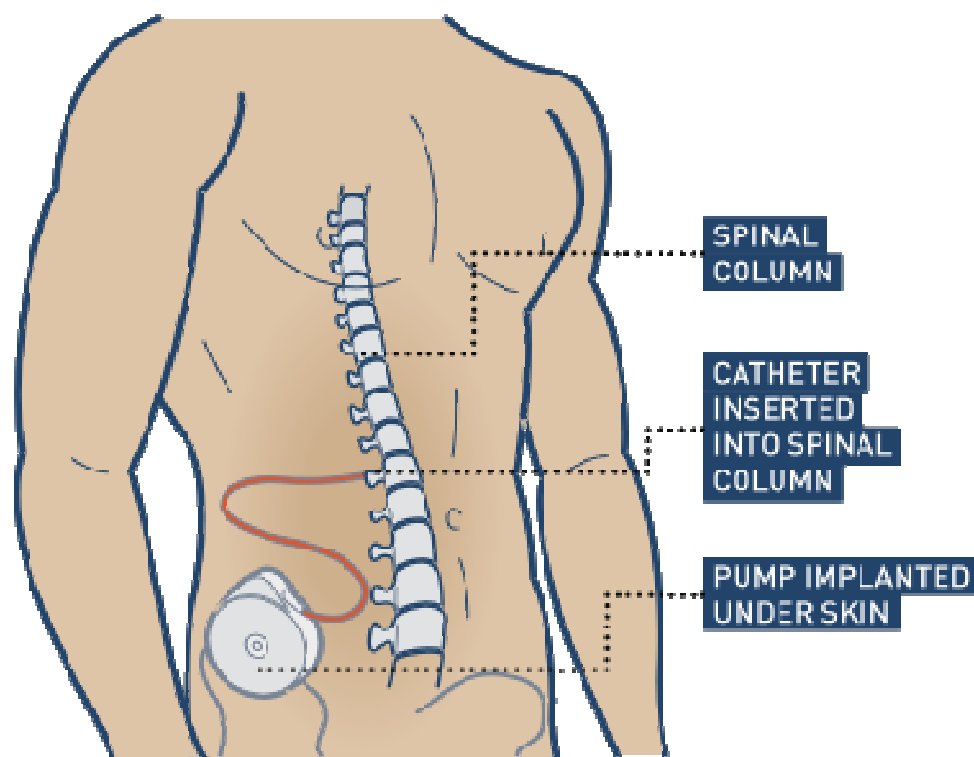


# Pharmacological Management of Spasticity

- Gaba Agonists - inhibitory neurotransmitter
  - Baclofen – side effects may include sedation, drowsiness, ataxia, respiratory and cardiovascular depression
  - Diazepam – side effects may include sedation, drowsiness, memory and attention impairments
- Alpha Agonists
  - Clonidine – side effects may include hypotension, bradycardia, sedation, and dizziness
  - Tizanidine – liver function tests should be administered due to the risk of hepatotoxicity
- Calcium Antagonists
  - Dantrolene – acts peripherally on muscle fibers and may also weaken muscles with voluntary control; may also cause mild liver enzyme elevations



# Management of Spasticity with Intrathecal Baclofen





# Management of Spasticity with Chemodenervation

- Botulinum Toxin Injection
  - Localized treatment injected intramuscularly into specific muscles
  - Effects last approximately 3 months
- Phenol Neurolysis
  - Injection to induce axon demyelination and destruction
  - Must be injected into pure motor nerve branches as it can cause dysesthesia to sensory nerves
  - Effects last approximately 4-12 months

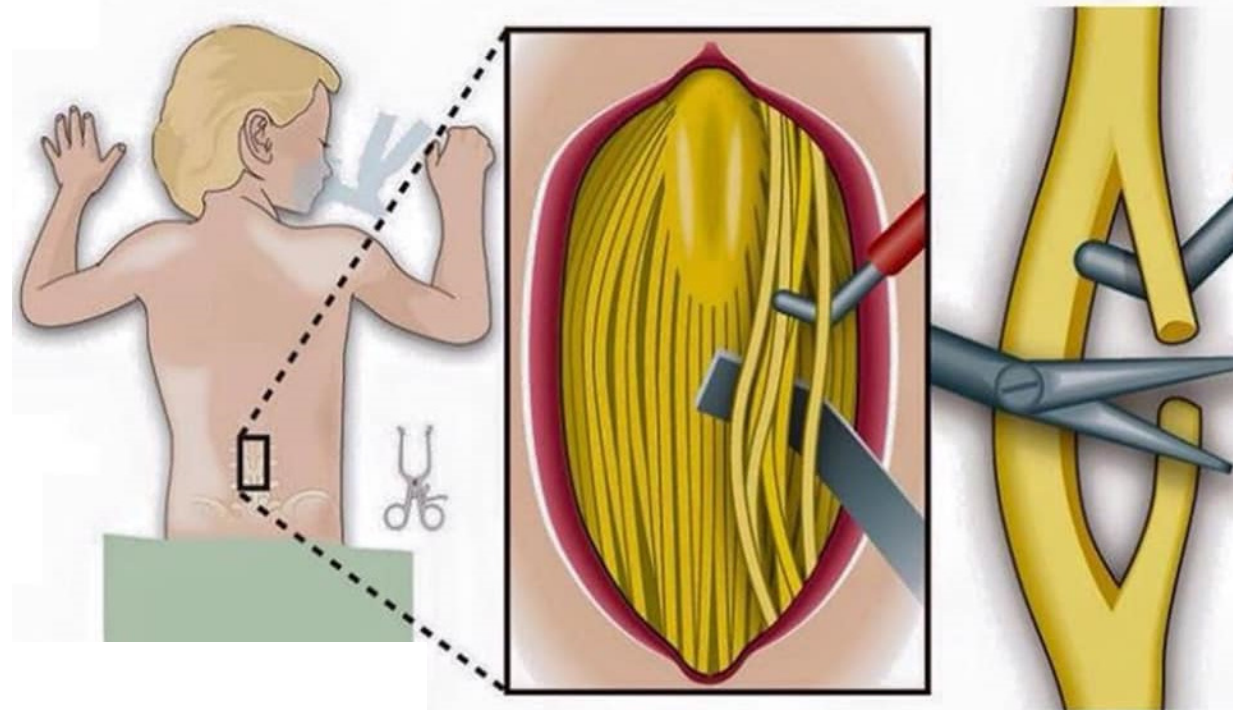






# Surgical Management for Reduction of Spasticity

- Selective Dorsal Rhizotomy –
  - Severing of the nerve fibers that contribute to spasticity
  - One-time procedure
  - Results are permanent





# Surgical Management of Contractures

- Surgical intervention may be warranted if the reduced ROM is-
  - Impeding care and hygiene
  - Interfering with mobility or wheelchair positioning
  - Causing skin breakdown
  - Causing intolerable pain
  - Conservative methods have failed
- Types of surgeries-
  - Surgical release of affected muscles
  - Tenotomy
  - Tendon lengthening
  - Joint capsule release
  - Removal of heterotopic bone





## Heterotopic Ossification - Neurogenic

- Lamellar bone formation
- Soft tissues surrounding peripheral joints
- SCI incidence:
  - 10-53%, incidental radiographic findings to ankylosis
  - 20-30% has significant ROM reduction
  - 3-8% ankylosis
  - Below the level of the injury
  - Incidence in descending order (Hip, knee, elbow, shoulder, hand)





# Heterotopic Ossification - Neurogenic

## Clinical findings:

- Reduction in ROM
- Peri-articular swelling
- Pain in the presence of sensory sparing
  - A.D. in neurological levels of T6 and above
- Joint erythema and warmth
- Low grade fevers
- Increased spasticity





# Heterotopic Ossification - Treatment

- ROM
- NSAIDs – Indomethacin
- Surgical resection of the matured HO
  - To improve ROM, sitting, standing, wound risk, and spasms
  - 20-60% significant HO recurrence rate



## Conclusion

- Living with contractures can greatly impact one's quality of life.
- Management of contractures requires coordinated care from the entire rehabilitation team, including the patient, caregivers, and medical professionals.
- The best management of contractures is prevention!





Questions? 



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תודה  
Dankie Gracias  
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Köszönjük Terima kasih  
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**Thank You** Tak  
感谢您 Obrigado Teşekkür Ederiz  
Σας ευχαριστούμε 감사합니다  
Bedankt Děkujeme vám  
ありがとうございます  
Tack

